



❷ Toward Better Modeling of Supercritical Turbulent Mixing

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A study was done as part of an effort to develop computational models representing turbulent mixing under thermodynamic supercritical (here, high pressure) conditions. The question was whether the large-eddy simulation (LES) approach, developed previously for atmospheric-pressure compressible-perfect-gas and incompressible flows, can be extended to real-gas non-ideal (including supercritical) fluid mixtures. [In LES, the governing equations are approximated such that the flow field is spatially filtered and subgrid-scale (SGS) phenomena are represented by

models.] The study included analyses of results from direct numerical simulation (DNS) of several such mixing layers based on the Navier-Stokes, total-energy, and conservation-of-chemical-species governing equations.

Comparison of LES and DNS results revealed the need to augment the atmospheric-pressure LES equations with additional SGS momentum and energy terms. These new terms are the direct result of high-density-gradient-magnitude regions found in the DNS and observed experimentally under fully turbulent flow condi-

tions. A model has been derived for the new term in the momentum equation and was found to perform well at small filter size but to deteriorate with increasing filter size. Several alternative models were derived for the new SGS term in the energy equation that would need further investigations to determine if they are too computationally intensive in LES.

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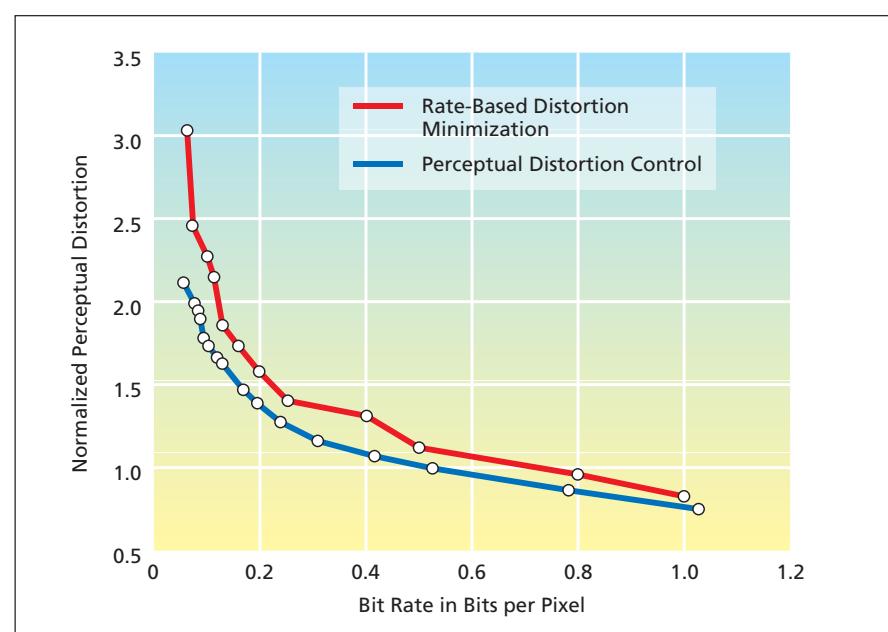
❷ JPEG 2000 Encoding With Perceptual Distortion Control

The bit rate for a given level of perceptual distortion is minimized.

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An alternative approach has been devised for encoding image data in compliance with JPEG 2000, the most recent still-image data-compression standard of the Joint Photographic Experts Group. Heretofore, JPEG 2000 encoding has been implemented by several related schemes classified as rate-based distortion-minimization encoding. In each of these schemes, the end user specifies a desired bit rate and the encoding algorithm strives to attain that rate while minimizing a mean squared error (MSE). While rate-based distortion minimization is appropriate for transmitting data over a limited-bandwidth channel, it is not the best approach for applications in which the perceptual quality of reconstructed images is a major consideration. A better approach for such applications is the present alternative one, denoted perceptual distortion control, in which the encoding algorithm strives to compress data to the lowest bit rate that yields at least a specified level of perceptual image quality.

Some additional background information on JPEG 2000 is prerequisite to a meaningful summary of JPEG encoding with perceptual distortion control. The JPEG 2000 encoding process includes two subprocesses known as tier-1 and



The **Normalized Perceptual Distortion** in compressed data from a test image were computed for compression by a JPEG 2000 perceptual-distortion-control and a JPEG 2000 rate-based distortion-minimization encoding algorithm.

tier-2 coding. In order to minimize the MSE for the desired bit rate, a rate-distortion-optimization subprocess is introduced between the tier-1 and tier-2 subprocesses. In tier-1 coding, each coding

block is independently bit-plane coded from the most-significant-bit (MSB) plane to the least-significant-bit (LSB) plane, using three coding passes (except for the MSB plane, which is coded using